FLUID COUPLER

BACKGROUND OF THE INVENTION

This invention relates to a fluid coupler comprising male and female coupler members.

A fluid coupler comprises a female coupler member and a male coupler member adapted to be inserted into and detachably connected to the female coupler member. The male and female coupler members are securely connected to each other by engagement of locking balls provided in the female coupler member with an annular locking ball receiving recess formed on the exterior surface of the male coupler member. To insert the male coupler member into the female coupler member, an operator needs to shift a locking ball confining sleeve provided on the female coupler member, which has confined the locking balls to a position in which the locking balls partly project into a male coupler receiving hole of the female coupler member for engagement with the locking ball receiving recess, against a spring force to a position where the sleeve allows the locking balls to be moved radially outwardly by the male coupler member.

There is another type of fluid coupler in which a locking ball confining sleeve of a female coupler member has a slanted or conical interior surface for engaging with locking balls. The sleeve is urged by a spring to a position where the slanted interior surface engages with locking balls and positions them at a recess engaging position where the locking balls engage with a locking ball receiving recess of a male coupler member. An operator can insert the male coupler member into the female coupler member by simply pushing the former into the latter so that the locking ball confining sleeve is shifted by a force applied by the male coupler member to the slanted interior surface through the locking balls with the spring being compressed. When the male coupler member is completely inserted into the female coupler member, the locking ball confining sleeve is returned by the

spring to an initial position where the slanted interior surface confines the locking balls in the locking ball receiving recess. However, this type of fluid coupler involves a problem that the male coupler member may be accidentally disconnected from the female coupler member. Namely, if a large pulling force is (accidentally) applied to the male coupler member, the locking ball is urged by the male coupler member against the slanted interior surface of the sleeve and moves or displaces the locking ball confining sleeve from its locking ball confining position.

To solve this problem, another type of fluid coupler has been developed wherein a cylindrical support member is provided inside a female coupler member such that the cylindrical support member is urged to a position where the cylindrical support member supports locking balls to prevent the locking balls from projecting into the male coupler member receiving hole, thereby allowing a male coupler member to be inserted into the female coupler member. When the male coupler member is inserted into the female coupler member, the male coupler member pushes the cylindrical support member rearwards and, when the male couple member has been completely inserted into the female coupler member, a locking ball receiving recess of the male coupler member is radially aligned with the locking balls, whereby a locking ball confining sleeve is shifted by under a spring force to its locking ball confining position, so that the locking balls are moved radially inwardly into and confined in the locking ball receiving recess by the locking ball confining sleeve. While this type of fluid coupler solves the problem of accidental disconnection, it involves another problem, namely, its size, i.e., since cylindrical support member is provided inside the female coupler member, the size of the female coupler member must be made relatively large as compared with the other types of fluid couplers mentioned above.

SUMMARY OF THE INVENTION

An object of this invention is to provide a fluid coupler having a novel fastening mechanism which enables an operator to securely connect a male coupler member to a female coupler member by simply inserting the former into the latter, and which does not give rise to the problems stated relative to the prior art fluid couplers.

Another object of this invention is to provide a coupler member which may be employed in such a novel fluid coupler.

According to one aspect of this invention, there is provided a fluid coupler comprising

a female coupler member; and

a male coupler member; wherein

the female coupler member comprises:

a cylindrical member including an axial through hole having a first opening end for receiving the male coupler member and a second opening end opposite to the first opening end, the cylindrical member further including

a first radial through hole radially extending through the cylindrical member, and

a second radial through hole radially extending through the cylindrical member, the first radial through hole being positioned nearer to the first opening end than the second radial through hole;

a first locking ball received in the first radial through hole such that the first locking ball is radially movable in the first radial through hole;

a second locking ball received in the second radial through hole such that the second locking ball is radially movable in the second radial through hole;

a locking ball confining ring axially slidably disposed around the cylindrical member and having an inner surface formed with

a first locking ball relieving portion enabling the first locking ball to move radially outwardly to allow the male coupler member to be inserted into the axial through hole passing the first locking ball;

a first slanted portion extending radially inwardly from the first locking ball relieving portion in a direction toward one of the first and second opening ends, the slanted portion being axially aligned and engaged with the first locking ball;

a second locking ball relieving portion 16 enabling the second locking ball to move radially outwardly to allow the male coupler member to advance in the axial through hole passing the second locking ball;

a second slanted portion extending radially inwardly from the second locking ball relieving portion in the direction toward one of the first and second opening ends, the second slanted portion being axially aligned and engaged with the second locking ball; and,

a second locking ball pressing portion axially extending from an radially inward end of the slanted portion; and,

a spring urging the locking ball confining ring towards the other of the first and second opening ends; and,

wherein

when the male coupler member is not inserted into the female coupler member, the first locking ball is engaged by the first slanted portion to partly extend into the axial through hole and the second locking ball is engaged by the second ball pressing portion to partly extend into the axial through hole,

when the first locking ball is engaged by the male coupler member, which is being inserted into the axial through hole from the first opening end, the first locking ball is forcibly moved radially outwardly while moving the locking ball confining ring in an axial direction under a force applied by the first locking ball to the first slanted portion, thereby allowing the male coupler member to advance into the axial through hole,

when the male coupler member comes into engagement with the second locking ball after passing the first locking ball, the locking ball confining ring has been moved such that the locking ball pressing portion disengages from the second locking ball, thereby allowing the second locking ball to be radially outwardly to allow the male coupler member to advance further; and,

the male coupler member has an annular groove formed in the outer surface thereof which is radially aligned with the first and second locking balls, which have been moved radially outwardly to the first and second locking ball relieving portions, respectively, to receive the first and second locking balls thereinto so that the locking ball confining ring is returned by the spring to an initial position which the sleeve takes when the male coupler member is not inserted into the axial through hole of the female coupler member.

According to another aspect of the present invention, there is provided a coupler member of a fluid coupler comprising:

a cylindrical member having an axial through hole; and

a valve mechanism disposed in the axial through hole of the cylindrical member;

the valve mechanism comprising:

a valve holder slidably disposed in the axial through hole the valve holder being axially movable in the axial though hole

between an opening position and a closing position;

a rotatable valve;

a pivotal shaft for pivotally supporting the rotatable valve about a pivotal axis extending transversely with respect to the valve holder 25, 43; and,

a cam mechanism for effecting a rotational movement of the rotatable valve about the pivotal axis between an opening angular position wherein the rotatable valve allows fluid to flow through the coupler member and a closing angular position wherein the rotatable valve prevents fluid from flowing through the coupler member in response to the movement of the valve holder between the opening position and the closing position, respectively;

the cam mechanism having a cam profile hole extending through the rotatable valve;

a pin arranged such that the pin extends through the cam profile hole;

the cam profile hole cooperates with the pin such that when the valve holder is moved between the opening and closing positions, the pin engages with a wall defining the cam profile hole so that the rotatable valve is rotated between the opening angular position and the closing angular position.

BRIEF DESCRIPTION OF THE DRAWING

These and other features, aspects, and advantages of the present invention will become apparent with reference to the following description, claims and accompanying drawings, where

Fig. 1 is a longitudinal cross-sectional view of a fluid coupler in accordance with the present invention showing a condition in which male and female coupler members are disconnected from each other;

Fig. 2 is a view taken along a line A-A in Fig. 1;

Fig. 3 is a longitudinal cross-sectional view of the fluid coupler shown in Fig. 1 in which the male and female coupler members are connected to each other;

Fig. 4 is a view taken along a line B-B in Fig. 3;

Fig. 5 is a plan view of a cylindrical coupler member of the fluid coupler shown in Fig. 1;

Fig. 6 is a view taken along a line C-C in Fig. 5;

Fig. 7 is a front view of a locking ball confining ring employed in the fluid coupler shown in Fig. 1;

Fig. 8 is a view taken along a line D-D in Fig. 7;

Fig. 9a is a view of a forward portion of the cylindrical member of the female coupler member of Fig. 1 which is split at a position in its circumferential direction and unfolded to be flat to show a positional relationship of first and second radial through holes formed in the forward portion of the cylindrical member;

Fig. 9b is a view of a locking ball confining ring employed in the female coupler member which is split at a position in its circumferential direction and unfolded to be flat to show an interior surface of the locking ball confining ring;

Fig. 10 is a view taken along a line E-E in Fig. 1;

Fig. 11 is a view taken along a line F-F in Fig.3;

Fig. 12 is a longitudinal cross-sectional view of the cylindrical member of the female coupler member;

Fig. 13 is a plan view of a valve employed in the fluid coupler of Fig. 1 under a closing condition;

Fig. 14 is a side elevation view of the valve of Fig. 13;

Fig. 15 is a bottom view of the valve of Fig. 13;

Fig. 16 is a view taken along a line G-G in Fig. 13;

Fig. 17 is a plan view of the valve of Fig. 13 under an opening condition;

Fig. 18 is a side elevation view of the valve of Fig. 17;

Fig. 19 is a bottom view of the valve of Fig. 17;

Fig. 20 is a view taken along a line H-H in Fig. 17;

Fig. 21 is a longitudinal cross-sectional view of the fluid coupler of Fig. 1 in which the male coupler member is in a first stage of insertion into the female coupler member; and,

Fig. 22 is a view similar to Fig. 21 in which the male coupler member is in a second stage of insertion into the female coupler member.

DETAILED DESCRIPTION OF THE INVENTION

With reference to the accompanying drawings, there is shown a fluid coupler in accordance with the present invention having a female coupler member 1 and a male coupler member 2. The female coupler member 2 has a locking mechanism 3, as explained below, for securely connecting the male coupler member 2 to the female coupler member 1.

The female coupler member 2 has a cylindrical member 8 including: an axial through hole 4; a plurality of first radial through holes 9 which are spaced apart from each other in a circumferential direction, and which respectively radially extend through the cylindrical member 8; a plurality of second radial through holes 10 which are spaced apart form each other in a circumferential direction, and which respectively radially extend through the cylindrical member 8; a plurality of first locking balls 11 respectively received in the first radial through holes 9 such that the first locking balls 11 are radially movable in the first radial through holes 9; and, a plurality of second locking balls 12 respectively received in the second radial through holes 10 such that the second locking balls 12 are radially movable in the second radial through hole 10. Further, a locking ball confining ring 13b is axially slidably disposed around the cylindrical member 8.

As shown in Fig. 5 and Fig. 9a, the first radial through holes 9 are positioned closer than the second radial through holes 10 to an opening end of the axial through hole 4 for receiving the male coupler member 1. The radial through holes 9 and 10 are tapered radially inwardly to prevent the locking balls 11 and 12 from moving out from the radial through holes 9 and 10.

Fig. 7 is a front view of a locking ball confining ring 13b, and Fig. 8 is a view taken along a line D-D in Fig. 7. Fig. 9b is a view of the locking ball confining ring 13a which is, for the sake of clarity of illustration, split at a position in its circumferential direction and unfolded to be flat to show an

interior surface of the locking ball confining ring 13b. As will be understood from Figs.1, 7, 8 and 9b, the inner surface of the locking ball confining ring 13b has a first annular surface or first locking ball relieving portion 14; a second annular surface or second locking ball pressing portion 18 axially spaced away from the first annular surface 14, and having a diameter smaller than that of the first annular surface 14; a conical surface or slanted annular portion 15 extending between the first annular surface or first locking ball relieving portion 14 and the second annular surface or second ball relieving portion 16; and, a plurality of recesses or second slanted portions 17 extending from a portion on the second annular surface 18 adjacent to the slanted annular surface 15 through the annular slanted surface 15 towards the first annular surface or first locking ball relieving portion 14.

The locking ball confining ring 13b is surrounded by a sleeve 13a, and is urged by a coil spring 21 forwardly to engage with the stepped portion 19 of the sleeve 13a so that the coil spring 21 and the sleeve 13a are urged to the position shown in Fig. 1 wherein the sleeve 13a and the locking ball confining ring 13b are stopped by a stop ring 20. A forward end 21a of the coil spring 21 is bent to extend radially inwardly and engage with a radially extending recess 22 (Fig. 9b) formed in the locking ball confining ring 13b; and, further, slidably engages with an axially extending groove 8a (Figs. 1, 9a and 12) formed in the outer surface of the cylindrical member 8 so that the locking ball confining ring 13b is prevented from rotating about an axis thereof, while being permitted to axially move on the cylindrical member 8. Figs. 9a and 9b illustrate a positional relationship between the radial through holes 9 and 10 and the configuration of the inner surface of the locking ball confining ring 13b.

When the locking ball confining ring 13b is positioned at a forward end position as shown in Fig. 1, wherein the male coupler member 2 is not

inserted into the female coupler member 1, or as shown in Fig 3, wherein the male coupler member 2 is completely inserted into the female coupler member 1, the first locking balls 11 are engaged by a radially inward end portion of the first slanted portion 15 and partly extend into the axial through hole 4, while the second locking balls 12 are engaged by the second ball pressing portion 18 and partly extend into the axial through hole 4.

The male coupler member 2 has a cylindrical member 23 having an axial through hole 5. The cylindrical member 23 has a portion to be slidably inserted into the axial through hole 4 which is provided on its outer surface with a conical portion at a forward end thereof and a locking ball receiving recess 24 at a rearward portion thereof.

Upon insertion of the male coupler member 2 into the female coupler member 1, as the male coupler member advances in the axial through hole 4 towards the left end of the axial through hole 4, as viewed in Fig. 1, the conical portion of the forward end of the male coupler member 2 first engages with the first locking balls 11 to urge the first locking balls 11 radially outwardly, whereby the locking ball confining ring 13b is advanced rearwards or leftwards to allow the locking balls to move radially outwardly and, thus, the male coupler member 2 to continue its advancement. When the conical portion of the forward end of the male coupler member 2 comes into engagement with the second locking balls 12, the second locking ball pressing surface 18 has been moved rearwards to disengage from the second locking balls 12. As the male coupler member 2 is further advanced, the male coupler urges the second locking balls 12 radially outwardly to further move the locking ball confining ring 13b rearwards. When the male coupler member 2 has reached a connection position where the male coupler member 2 is completely inserted into the female coupler member 1, the locking ball receiving recess 24 of the male coupler member 2 is radially aligned with the first and second radial through holes 9 and 10, thereby allowing the locking

ball confining ring 13b to be returned by the coil spring 21 to its forward position while forcibly moving the locking balls 11 and 12 radially inwardly into the locking ball receiving recess 24. As a result, the first locking balls 11 are pressed by the slanted surface 15 and the second locking balls 12 are pressed by the second locking ball pressing surface 18 (Fig. 3). As will be apparent from the foregoing explanation, an operator can effect insertion of the male coupler member 2 by holding the sleeve 3a. As shown in the accompanying drawings, both the female coupler member 1 and the male coupler member 2 have valve mechanisms 6 and 7 which are provided in the axial through holes 4 and 5, respectively. Since the valve mechanisms 6 and 7 have the same construction, detailed explanation of only the valve mechanism 6 will be given below, so as to avoid unnecessary repetition.

The valve mechanism 6 of the female coupler member comprises a slidable valve holder 25 axially slidably disposed in the axial through hole 4, and a rotatable valve 26. The slidable valve holder 25 is urged by a coil spring 28 forwards and, when the male coupler member 2 is not inserted into the female coupler member 1, is urged against a cylindrical stop 29 which is securely mounted on the interior surface of the axial through hole 4 by means of screw threads 30.

As shown in Figs. 1 and 2, the slidable valve holder 25 has a forward cylindrical portion 25a with a though hole 35, a rearward cylindrical portion 25b with a through hole 36, and an intermediate portion 33 with a though hole 37 positioned between the forward and rearward cylindrical portions. The intermediate portion 33 has right and left side walls supporting the rotatable valve 26 with a pair of pivotal shafts 34, 34 which are positioned at opposite sides of the rotatable valve 26 and aligned with each other along a pivotal axis normal to the axis of the axial through hole 4. The rotatable valve 26 is rotatable between an opening angular position shown in Fig. 3, in which the through hole 37 is axially aligned with the through hole 35 of the

forward cylindrical portion and the through hole 36 of the forward cylindrical portion, and a closing angular position shown in Fig. 1, in which the through hole 37 is aligned with neither the axial through hole 35 of the forward cylindrical portion nor the through hole 36 of the forward cylindrical portion, and the outer surface 26a of the rotatable valve sealingly engages with a sealing ring 38 provided around the opening end 35 to prevent fluid from flowing through the valve mechanism. Between the valve mechanism 6 and the cylindrical member 8, there is provided a cam mechanism for moving the rotatable valve 26 between the opening angular position (Fig. 3) and the closing angular position (Fig. 1) stated above. The cam mechanism has a cam profile hole 39 extending through a portion 26b of the rotatable valve 26 in a direction of the pivotal axis of the rotatable valve 26 and along a cam profile in a plane normal to the pivotal axis and, a pin 41 arranged such that the pin extends through the cam profile hole 39 in parallel with the pivotal axis. The cam profile hole 39 is profiled such that when the slidable valve holder 25 is moved between the opening position (Fig. 3) and the closing position (Fig. 1), the pin 41 engages with a wall defining the cam profile hole 39 so that the pin 41 imposes a rotational force on the rotatable valve 26 to rotate the rotational valve between the opening angular position (Fig. 3) and the closing angular position (Fig. 1). In the embodiment illustrated in the drawings, opposite ends of the pin 41 pass inclined elongated holes 40, 40 (Figs. 13, 14, 17 and 18) formed in the left and right walls of the intermediate portion 33 of the slidable valve holder 25 and engage with a pair of rectangular holes 42, 42 (Figs. 10-12) formed in the cylindrical stop 29. The hole 42 vertically extends through the cylindrical stop 29 and has a rectangular cross section. An axial length of the cross section of the hole 42 is slightly larger than the diameter of the pin 41 to substantially prevent the pin 41 from moving in the axial direction. When the slidable valve holder 25 is moved between the closing position and the

opening position, the walls of the inclined elongated holes 40, 40 cooperate with the walls of rectangular holes 42, 42 to slightly move the pin 41 vertically (Figs. 10 and 11). In Fig. 1, 31, 32 and 60 denote sealing rings. (Break) 19:45. (restart) 20:00

The valve mechanism set forth above is distinguishable from the type of valve mechanism employed in a prior art fluid coupler member in which forward and rearward cylindrical portions of a slidable valve holder are separated from each other and a rotatable valve is held by the forward and rearward cylindrical portions which are urged against the rotatable valve by spring means in such a manner that the rotatable valve is rotated by a cam mechanism similar to that of the present invention as explained above. In the prior art valve mechanism, due to the construction described above, when the slidable valve holder is axially moved between opening and closing positions, a large friction force is generated between the rotatable valve and the forward and rearward cylindrical portions. In contrast, since the rotatable valve of the valve mechanism of the present invention is pivotally supported by pivotal shafts and, only a small friction force is generated between the rotatable valve and the forward and rearward cylindrical portions, which enables an operator to insert the male coupler member into the female coupler member using little force as compared with the prior art valve mechanism. The generation of only a small friction force between the rotatable valve and the forward and rearward cylindrical portions also enable that the valve mechanism of the present invention to have long working life.

The valve mechanism 7 of the male coupler member 2 is substantially the same as the valve mechanism 6 of the female coupler member 1 and comprises, as main elements, a slidable valve holder 43, a rotatable valve 50 with a cam profile hole 7 and a pin 59 extending through the cam profile hole 7.

Although the present invention has been described in terms of a specific embodiment, it is anticipated that alternations and modifications thereof will no doubt become apparent to those skilled in the art. It is therefore intended that the following claims be interpreted as covering all such alternations and modifications as fall within the true spirit and scope of the invention.